Vernier LabPro™
User's Manual

Vernier Software & Technology
13979 SW Millikan Way
Beaverton, Oregon 97005-2886

(503) 277-2299
FAX (503) 277-2440
www.vernier.com
info@vernier.com

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Introduction

The Vernier LabPro™ is a versatile data collection interface that can be used to collect data in a variety of ways in the classroom or in the field. It can be used with a computer, with a TI Graphing Calculator, or as a stand-alone data logger. More than forty sensors are available, including an Oxygen Gas Sensor, Relative Humidity Sensor, pH Sensor, Ion Selective Electrodes, Motion Detector, Accelerometers, etc.

By following this guidebook, you will learn to:

- Set up and collect data with a Macintosh™ or Windows™ computer through either the serial or USB port.
- Set up and collect data with a TI-73, TI-82, TI-83, TI-83 Plus, TI-86, TI-89, TI-92, or TI-92 Plus Texas Instruments Graphing Calculator.
- Use LabPro as a stand-alone data logger, and then retrieve data with a computer or a TI Graphing Calculator.

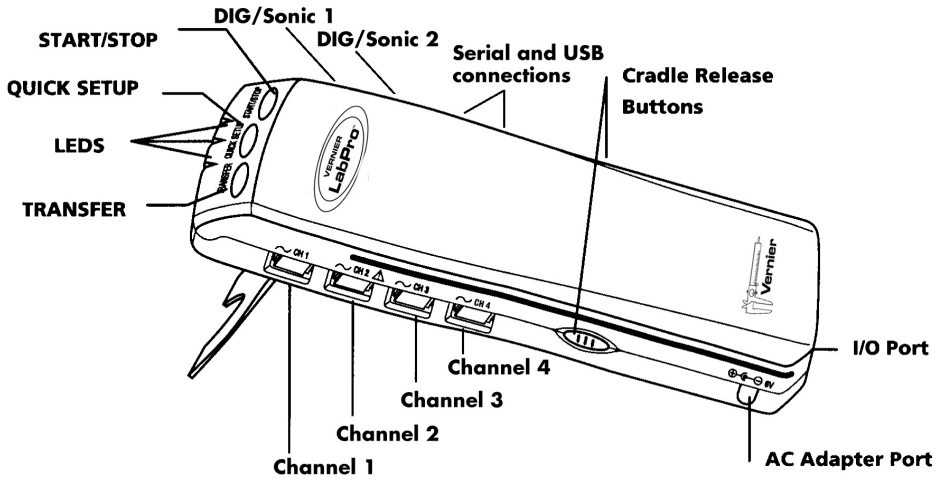
These procedures are easier and faster than you may think.

LabPro Components

The LabPro package contains all the parts you need to connect LabPro to a computer or TI Graphing Calculator. Those parts include

- LabPro interface
- PC serial cable
- Macintosh adapter for serial cable
- USB cable
- 6-volt AC power supply
- Voltage probe
- TI Graphing Calculator cradle
- Short calculator-to-calculator link cable
- User's Manual

The LabPro interface has three buttons, three LEDs, four analog channels (CH 1, CH 2, CH 3, and CH 4), two digital channels (DIG/SONIC 1 and DIG/SONIC 2), a serial computer connection, a USB computer connection, a piezo speaker, and a calculator I/O port.



Buttons

The three buttons on the top of LabPro are used for the following purposes:

- TRANSFER begins transfer of calculator programs or applications (apps) between LabPro and an attached TI graphing calculator.
- QUICK SET-UP clears any data stored in LabPro's memory, then polls all channels for auto-ID sensors and sets them up to collect data. QUICK SET-UP is used when neither a computer nor calculator are attached to LabPro and works only with auto-ID sensors.
- START/STOP begins sampling for Quick Set-Up. Sampling continues until the default number of samples is collected or you press START/STOP again. This button also acts as a manual trigger for certain data-collection modes.

Lights

LabPro has three lights that indicate the LabPro status.

- Red indicates an error condition.
- Yellow indicates that LabPro is ready to collect data samples.
- Green indicates LabPro is collecting data.

Beeps

LabPro has a piezo speaker that makes four kinds of sounds or "beeps".

- A "good" beep is a medium tone followed by a high tone.
- A "caution" beep is a medium tone followed by another medium tone.
- A "bad" beep is a medium tone followed by a low tone.
- A "tick" sound is made when a key is pressed.

Appendix B contains a complete description of the conditions that cause these sounds.

Using LabPro with a Computer

This section provides the basics for collecting data with LabPro on a Macintosh or Windows computer. All you have to do is connect LabPro, install the software, attach one or more sensors, start the Logger *Pro*™ 2.0 software, and you are ready to collect data.

Computer and Software Requirements

To use LabPro on a computer, you will need Logger *Pro* 2.0 software[1] running on one of the following computers:

- A Power Macintosh running System 7.6.1 or newer with at least 16 MB RAM, 10 MB of hard disk space and an unused modem, printer, or USB port.
- A Pentium or compatible PC running Windows 95/98/2000 or NT system software with at least 16 MB RAM, 10 MB of hard disk space and an unused serial or USB port. (Computers running Windows 3.1 may also work. See the Logger *Pro* manual for details.)

Before you continue, check to see that Logger *Pro* is installed on your computer. If not, now would be a good time to install it. The *Logger Pro User's Manual* describes the software installation.

Attaching LabPro to a Computer

The LabPro computer connection is located on the right side of the interface. The sliding door found there can be moved left to reveal the serial port or to the right to reveal the USB port.

Serial Port and Digital Channels (USB Port is behind the sliding door)

Serial Connection to a Macintosh Computer

Attach the rectangular end of the Macintosh serial adapter to the PC serial cable. Plug the round end of the Macintosh serial adapter into the computer's modem or printer port. Slide the door on the computer connection to the left and plug the other end of the serial cable into the serial connection on LabPro.

USB Connection to a Macintosh Computer

Slide the door on the computer connection to the right and plug the square end of the USB cable into the LabPro USB connection. Plug the other end of the USB cable into the USB port on the Macintosh computer.

[1] Logger *Pro* software is available from Vernier Software & Technology for $65 (order code LP).

Serial Connection to a PC

Slide the door on the computer connection to the left and plug the round mini-DIN end of the PC serial cable into the serial connection on LabPro. Plug the other end of the serial cable into the serial port on the computer.

USB Connection to a PC

Slide the door on the computer connection to the right and plug the square end of the USB cable into the LabPro USB connection. Plug the other end of the USB cable into the USB port on the PC.

Providing Power to LabPro

AC power or batteries can power LabPro. To use LabPro with the AC power supply, plug the round plug on the 6-volt power supply into the side of the interface. Shortly after plugging the power supply into the outlet, the interface will run through a self-test. You will hear a series of six beeps and see red, yellow, and green blinking lights indicating a successful power up.

To use LabPro with batteries, remove the battery compartment cover from the underside of the interface. Insert four AA batteries and replace the compartment cover. Shortly after connecting to power, the interface will run through a self-test. You will hear a series of six beeps and see red, yellow, and green blinking lights indicating a successful power up. If the self-test is not successful, make sure that the batteries are installed correctly and that they are still useable.

Connecting Sensors

Sensors can be divided into two basic types—analog and digital. Examples of analog sensors are Temperature Probes, pH sensors, Force Sensors, Oxygen Gas Sensors, etc. Up to four analog sensors can be connected to LabPro. Four jacks for the analog sensors are located on the same side as the AC Adapter Port. The analog ports accept British Telecom-style plugs with a right-hand connector.

The tutorial in the next section uses the Vernier Stainless-Steel Temperature Probe. If one of these probes is available, connect it to channel CH 1.

Examples of digital sensors are Motion Detectors, Radiation Monitors, Photogates, and Rotary Motion Sensors. Up to two digital sensors can be connected to LabPro. The digital ports accept British Telecom-style plugs with a left-hand connector. Notice that analog and digital sensors are "keyed" differently, preventing them from being connected to the wrong port.

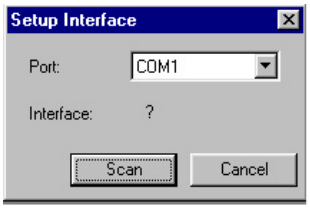
Vernier sensors purchased after April 2000 either have a British Telecom connector or they are shipped with an adapter. These sensors will plug directly into LabPro. You may have older sensors that you want to connect to LabPro, and they probably can be connected—with the proper adapter. Most of our older analog sensors have a round 5-pin DIN plug. The DIN-to-

BTA adapter (order code DIN-BTA, $5) can be purchased for those sensors. Other sensors may also be adaptable. See Appendix C or contact us for further details.

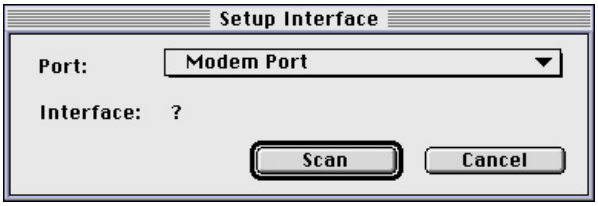
Starting Logger *Pro* Software and Preparing to Collect Data

Locate the Logger *Pro* icon on your computer and double-click on it, or use the Start menu (Windows 95/98/2000/NT). An important feature of LabPro is its ability to detect auto-ID sensors, and automatically set up an experiment.[2]

The computer will attempt to communicate with LabPro. If you see the following message, then Logger *Pro* is having trouble communicating with LabPro. Select the correct port and click Scan. If this does not work, consult Appendix A.

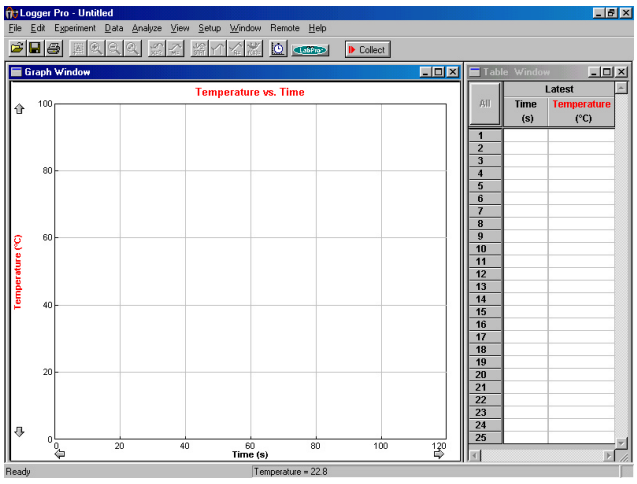


Windows Setup Interface Dialog Box



Mac Setup Interface Dialog Box

If you have connected a Stainless-Steel Temperature Probe and the computer has detected the LabPro interface, you will see the following screen, which shows a graph of Temperature *vs*. Time.



Notice how the program automatically identified the temperature probe (an auto-ID sensor). The current temperature reading is displayed in the status bar at the bottom of the screen. The default data collection mode is time graph. In this example, you have a Temperature Probe, reading in Celsius, and collecting data as a function of time for 120 seconds. If you now

[2]The Vernier lab manuals (see Appendix C) also contain experiment files with sensor and mode settings.

disconnect the Temperature Probe, connect a different auto-ID sensor, and choose New from the File menu, Logger *Pro* will set up a new experiment for the new sensor.

You are now ready to collect data. The next section is a tutorial that uses our Stainless-Steel Temperature probe to investigate the response time of the temperature probe. After completing the tutorial, you may want more detailed information on LabPro or Logger *Pro*, or you may want experiments for a particular course. The following manuals provide additional help. They are described in Appendix C.

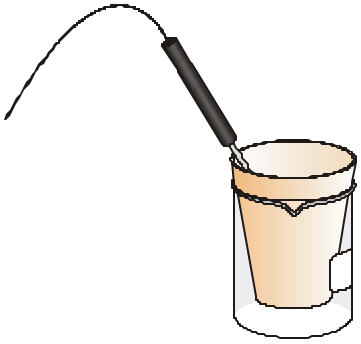
Physical Science with Computers
Biology with Computers
Chemistry with Computers
Physics with Computers
Water Quality with Computers
Logger Pro User's Manual
Logger Pro Tutorials
LabPro Technical Reference Manual

Tutorial: Temperature Measurement with Logger *Pro*

A good way to acquaint yourself with LabPro is by performing a simple experiment. Using this tutorial, you will take measurements using a temperature sensor. Follow the simple steps and you are well on your way to collecting and analyzing data with a computer.

MATERIALS

Power Macintosh or Windows PC
LabPro interface
Logger *Pro* software
Vernier Stainless-Steel Temperature Probe
One 250-mL beaker or cup
100 mL hot water



PROCEDURE

1. Place about 100 mL of hot water into a 250-mL beaker or a cup.
2. Plug the Stainless-Steel Temperature Probe into channel CH 1 on LabPro, and lay the temperature probe on the tabletop.
3. Start the Logger *Pro* software. Logger *Pro* will detect the auto-ID sensor, set the data collection parameters, and computer display. In this case, collection parameters are 1.0 sample per second and 120 samples. The program displays a graph and data table on the computer. The vertical axis of the graph will have temperature scaled from 0 to 100°C. The horizontal axis will have time scaled from 0 to 120 seconds. You are ready to collect data.
4. Click

to begin data collection.
5. Wait about 10 seconds and place the Temperature Probe into the cup of hot water, as shown above. Allow Logger *Pro* to complete data collection.
6. Notice that the sensor does not read the new temperature instantly; it takes a moment to respond.
7. Now that the run is complete, pull down the Analyze menu and choose Examine. The cursor will become a vertical line. As you move the cursor across the screen, temperature and time values corresponding to the cursor position will be displayed. Move the cursor to the point when the probe was first placed in the hot water. Record that time. Move the cursor to find the highest temperature, and record that time. How long did it take for the temperature sensor to stabilize at the water's temperature?

This tutorial is an example of how easy it is to collect and analyze data with LabPro and a computer. The auto-ID Stainless-Steel Temperature Probe simplified the experiment setup, but the use of non auto-ID sensors is almost as easy. All you have to do is connect the sensor or sensors, and open up an appropriate experiment file. Logger *Pro* software has over 500 experiment files. This set of files also includes experiments from our lab manuals—*Biology with Computers*, *Chemistry with Computers*, *Physical Science with Computers*, *Physics with Computers*, and *Water Quality with Computers*.

Using LabPro with a Calculator

This section provides the basic steps for collecting data with LabPro and a Texas Instruments Graphing Calculator. All you have to do is connect the hardware pieces to the calculator, attach one or more sensors, start the DataMate calculator program, and you are ready to collect data.

LabPro Interface, TI-83 Plus Calculator, and Stainless-Steel Temperature Probe

Calculator Requirements

LabPro can be used with any of these TI Graphing Calculators:

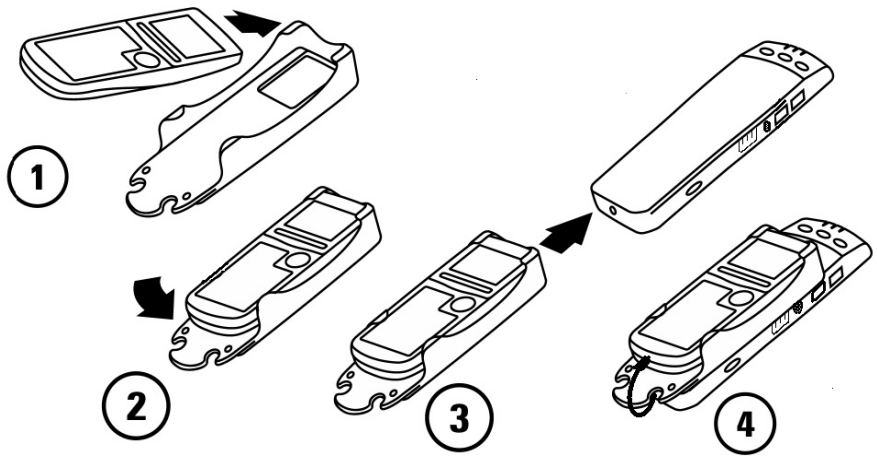
- TI-73
- TI-82
- TI-83
- TI-83 Plus
- TI-86
- TI-89
- TI-92
- TI-92 Plus

Because of their Flash ROM capabilities, we recommend the TI-73, TI-83 Plus, and TI-89 calculators.

Connecting the Equipment

The first step is to connect the calculator and LabPro.

1. Insert the upper end of the calculator into the cradle.
2. Press down on the lower end of the calculator until it snaps into place.
3. Slide the bottom of the cradle onto the top of LabPro until it clicks in place.
4. Plug one end of the LabPro-to-calculator cable into the I/O port in the lower end of the calculator. Plug the other end into LabPro.



Providing Power to LabPro

Batteries or AC power can power LabPro. To use LabPro with batteries, remove the battery compartment cover from the underside of the interface. Insert four AA batteries and replace the compartment cover. Shortly after connecting to power, the interface will run through a self-test. You will hear a series of beeps and blinking lights (red, yellow, then green) indicating a successful power up. If the self-test is not successful, make sure that the batteries are installed correctly and that they are still useable.

To use LabPro with the AC power supply, plug the round plug on the 6-volt power supply into the side of the interface. Shortly after plugging the power supply into the outlet, the interface will run through a self-test. You will hear a series of beeps and blinking lights (red, yellow, then green) indicating a successful power up.

Calculator Program Installation

When it is time to collect data, you will run a program called DataMate on the calculator. Chances are that DataMate is not on your calculator, but it is very easy to install.

1. Prepare the calculator to receive the program:
   - For the TI-73, TI-82, TI-83, and TI-83 Plus, turn on your calculator and press 2nd [LINK] (on the TI-73 press APPS, then select Link…). Press ▶ to RECEIVE, then press ENTER (Waiting… appears on your screen).
   - For the TI-86, turn on your calculator and press 2nd [LINK], then press F2 (Waiting… appears on your screen).
   - For the TI-89, TI-92, and TI-92 Plus, turn on your calculator and make sure that the calculator is on the Home screen. (You do not need to put the calculator into the Receiving mode as is required with the other calculators.)
2. Press the Transfer button on LabPro. "Receiving…" followed by a list of the loaded programs (or application) is displayed on the calculator.

3. A "Done" message on the calculator and two beeps from LabPro will indicate the transfer is complete. Press [2nd] [QUIT].
4. Verify that the programs have been successfully loaded.
   - On the TI-73, TI-82, TI-83, press [PRGM] to see DATAMATE and its subprograms.
   - On the TI-83 Plus, press [APPS] to see DATAMATE.
   - On the TI-86, press [PRGM] then [F1] to see DATAMATE and its subprograms.
   - On the TI-89, TI-92, and TI-92 Plus, press [2nd] [VAR-LINK] to see DATAMATE and its subprograms.

Connecting Sensors

Sensors can be divided into two basic types—analog and digital. Examples of analog sensors are Temperature Probes, pH Sensors, Force Sensors, Oxygen Gas Sensors, etc. Up to four analog sensors can be connected to LabPro. Four jacks for the analog sensors are located on the same side as the AC Adapter Port. The analog ports accept British Telecom-style plugs with a right-hand connector.

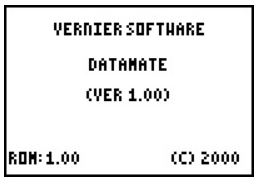
The tutorial in the next section uses the Vernier Stainless-Steel Temperature Probe. If one of these probes is available, connect it to channel CH1.

Examples of digital sensors are Motion Detectors, Radiation Monitors, Photogates, and Rotary Motion Sensors. Up to two digital sensors can be connected to LabPro. The digital ports accept British Telecom-style plugs with a left-hand connector. Notice that analog and digital sensors are "keyed" differently, preventing them from being connected to the wrong port.

Vernier sensors purchased after April 2000 either have a British Telecom connector or they are shipped with an adapter. These sensors plug directly into LabPro. You may have older sensors that you want to connect to LabPro, and they probably can be connected—with the proper adapter. Most of our older analog sensors have a round 5-pin DIN plug. The DIN to BTA adapter (order code DIN-BTA, $5) can be purchased for those sensors. Other sensors may also be adaptable. See Appendix C or contact us for further details.

Starting the DataMate Program and Preparing to Collect Data

Use the following steps to start the DataMate program on your calculator:



TI-73, TI-82, and TI-83 Calculators:

Press [PRGM], then press the calculator key for the number that precedes DATAMATE (usually [1]). Press [ENTER]. An introductory screen will appear, followed by the main screen.

TI-83 Plus Calculators:

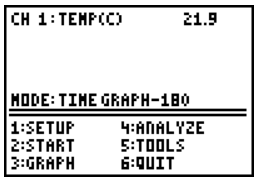
Press [APPS], then press the calculator key for the number that precedes DATAMATE. Press [ENTER]. An introductory screen will appear, followed by the main screen.

TI-86 Calculators:
Press [PRGM], press [F1] to select <NAMES>, and press the menu key that represents DataMate. (<DATAM> is usually [F1]). Press [ENTER], and wait for the main screen to load.

TI-89, TI-92, and TI-92 Plus Calculators:
Press [2nd] [VAR-LINK]. Use the cursor pad to scroll down to "datamate", then press [ENTER]. Press [)] to complete the open parenthesis of "datamate(" on the entry line. Press [ENTER]. An introductory screen will appear, followed by the main screen.

After the program begins, the calculator will try to communicate with the interface and check for auto-ID sensors. If this communication is successful, the main screen (shown below) will appear. If the calculator cannot establish a link with LabPro, this menu appears. If you choose Continue With Interface, the program will continue trying to communicate with the interface. If the calculator cannot establish a link with LabPro, a Link Error message will appear. Check that LabPro has power and that the link cable is properly connected. This message will continue to appear until the link problem is fixed.

This is the main screen that appears after the calculator and interface are communicating. In this example a Stainless-Steel Temperature Probe was connected and DataMate automatically identified the Temperature Probe, displayed the channel it was connected to and the current reading. DataMate also sets up a default time graph experiment for auto-ID sensors. In this example, an experiment was set up to collect data for 180 seconds.



You are now ready to collect data. The next section is a tutorial that uses our Stainless-Steel Temperature Probe to investigate the response time of the Temperature Probe. After completing the tutorial, you may want more detailed information on LabPro or DataMate, or you may want experiments for a particular course. The following manuals provide additional help. They are described in Appendix C.

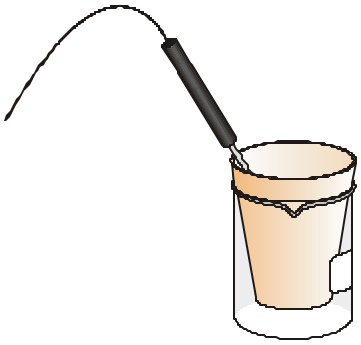
Physical Science with Calculators
Biology with Calculators
Chemistry with Calculators
Physics with Calculators
Water Quality with Calculators
LabPro Technical Reference Manual
DataMate Guidebook

Tutorial: Temperature Measurement with DataMate

A good way to acquaint yourself with LabPro is by performing a simple experiment. Using this tutorial you will take measurements using a Temperature Probe. Just follow the simple steps and you are well on your way to collecting and analyzing data with a calculator.

MATERIALS

TI Graphing Calculator
LabPro interface
DataMate program
Vernier Stainless-Steel Temperature Probe
One 250-mL beaker or cup
100 mL hot water



PROCEDURE

1. Place about 100 mL of hot water into a 250-mL beaker or a cup.
2. Plug the Stainless-Steel Temperature Probe into channel CH 1 on LabPro, and lay the Temperature Probe on the tabletop.
3. Start the DataMate program. Press CLEAR to reset the program. DataMate will detect the auto-ID sensor, set the data collection parameters, and display the current sensor reading. The experiment will collect temperature for 180 seconds.
4. Select START to begin data collection.
5. Wait about 10 seconds and place the Temperature Sensor into the cup of hot water as shown above. A live graph will appear on the calculator screen. You can either allow DataMate to complete data collection or press the STO▶ key to stop data collection.
6. After the data collection is complete, an autoscaled graph of the data will appear. Notice that the probe does not read the new temperature instantly; it takes a little while to respond. This is a characteristic of the sensor. Use the ▶ or ◀ keys (or the cursor pad on the TI-92) to examine the data points along the displayed curve of temperature *vs.* time. As you move the cursor right or left, the time (X) and temperature (Y) values of each data point are displayed below the graph. Move the cursor to the point when the probe was first placed in the hot water. Record that time. Move the cursor to find the highest temperature and record that time. How long did it take for the temperature sensor to stabilize at the water's temperature?

This tutorial is an example of how easy it is to collect and analyze data with LabPro and a TI Graphing Calculator. The auto-ID Stainless-Steel Temperature Probe simplified the experiment setup, but the use of non auto-ID sensors is easy too. All you have to do is select SETUP on

the main screen of DataMate. This will take you to the Setup screen. From here you can set up non auto-ID sensors and make changes to the data collection mode. Complete details on these procedures can be found in the *DataMate Guidebook*.

Full sets of experiments are available in our lab manuals—*Biology with Calculators*, *Chemistry with Calculators*, *Physical Science with Calculators*, *Physics with Calculators*, and *Water Quality with Calculators*.

Using LabPro Remotely

LabPro can collect data without being attached to a computer or calculator. Having a computer or calculator attached to LabPro is preferable, because it provides much more flexibility in your data collection and provides a screen for immediate feedback of your results. There are times, however, when disconnecting the computer or calculator from LabPro to collect data is useful. For example, remote data collection is perfect for gathering acceleration data on a roller coaster. There are three ways that LabPro can be used by itself to collect data:

- Using the Quick Setup feature of LabPro and auto-ID sensors, sensors can be set up and data collected without being attached to a computer or graphing calculator. After the experiment is done, either the computer or the calculator can retrieve the data.
- The computer can set up LabPro for remote data collection. LabPro can be removed from the computer for data collection, then reattached to the computer for data retrieval. The computer method also allows you to use sensors that are not auto-ID. You can also use the Selected Event data collection mode.
- The graphing calculator can set up LabPro for remote data collection. LabPro can be removed from the calculator for data collection, then reattached to the calculator for data retrieval.

Using Quick Setup on LabPro

The Quick Setup feature is very simple:

1. Set up LabPro for remote data collection.
   a. Connect your auto-ID sensor(s) to LabPro. (Sensors that are not auto-ID cannot be used with this method. The next two methods allow you to use auto-ID and/or non auto-ID sensors.)
   b. Press the QUICK SETUP button. The yellow LED will blink twice and two beeps will be heard verifying setup.

2. Collect data.
   a. When you are ready to collect data, press the START/STOP button. The green LED will flash during data collection.
   b. When data collection is complete, the green LED will stop blinking.[3] You do not need to press the START/STOP button to end data collection. (You can, however, stop data collection early by pressing the START/STOP button before data collection is finished.)

3. Retrieve the data.

   With a computer,

   a. Start Logger *Pro* (if it is not already running).
   b. Select Retrieve Data from LabPro from the Remote menu.
   c. Connect LabPro to the computer.
   d. The data will be transferred from LabPro into Logger *Pro*. The labels and the units in the column headings and on the graph may need to be changed to match the sensor.

[3] The duration of data collection will vary from sensor to sensor.

With a calculator,

a. You can retrieve the data by connecting the interface to a TI Graphing Calculator and starting DataMate. A message will appear stating "DATA COLLECTION IS DONE. . ."
b. Press ENTER to proceed to the main screen.
c. Select TOOLS from the main screen.
d. Select RETREIVE DATA from the TOOLS menu. The data will be retrieved and one or more graphs made available.

Computer Setup for Real Time Collect Method

Using the Setup for Real Time Collect Method, you will use a computer to set up LabPro, detach it for a real time data collection, then reattach it to the computer to retrieve the data. This gives you more flexibility than the Quick Setup Method. With this method, you can (a) use any sensors (not just auto-ID), (b) control the time between samples, and (c) control the number of data points collected (up to 12,000).

1. Set up LabPro for remote data collection
   a. Set up the sensors, LabPro, and Logger *Pro* just as you normally would to collect data in Real Time Collect mode.
   b. Be sure to save this setup in an experiment file.
   c. Instead of clicking the Collect button, select Set Up LabPro from the Remote menu.
   d. Follow the on-screen instructions to finish setup.
   e. Click the Setup button. The yellow LED on LabPro will come on, indicating that it is ready to collect data.
   f. Disconnect LabPro from the computer. If appropriate, exit the Logger *Pro* program.
2. Collect data.
   a. When you are ready to collect data, press the START/STOP button. The green LED will flash each time a reading is made.
   b. When data collection is complete, the green LED will stop blinking. You can, however, stop data collection early by pressing the START/STOP button before data collection is finished.
3. Retrieve the data.
   a. Connect LabPro to a computer.
   b. Start the Logger *Pro* software. A dialog box labeled "LabPro Has Data" will appear.
   c. Click the Open Experiment button, and open the experiment file you used in setting up the remote experiment.
   d. Click the Retrieve Data button on the dialog box.
   e. The data will be transferred from LabPro into Logger *Pro*.

Computer Setup for Selected Events Method

Using the Setup for Selected Events Method, you will use a computer to set up LabPro, detach it to collect individual data points, then reattach it to retrieve the data. With this method, you can use any sensors (not just auto-ID), and collect individual data points whenever you press the START/STOP button.

1. Set up LabPro for remote data collection
   a. Set up the sensors, LabPro, and Logger *Pro* just as you normally would to collect data using the Selected Events mode.
   b. Be sure to save this setup in an experiment file.
   c. Instead of clicking the Collect button, select Set Up LabPro from the Remote menu.
   d. Follow the on-screen instructions to finish setup.
2. Collect data.
   a. Every time you press the START/STOP button, LabPro will collect one data point. Up to 99 data points can be collected.
3. Retrieve the data.
   a. Connect LabPro to a computer.
   b. Start the Logger *Pro* software. A dialog box labeled "LabPro Has Data" will appear.
   c. Click the Open Experiment button, and open the experiment file you used in setting up the remote experiment.
   d. Click the Retrieve Data button on the dialog box.
   e. The data will be transferred from LabPro into Logger *Pro*.

Remote Data Collection with DataMate

This method gives you more control of the data collection than the Quick Setup method, because you have control of which sensors and what data collection sample interval will be used. This is how it works:

1. Attach one or more sensors to LabPro. These sensors can be auto-ID or non auto-ID sensors.
2. Start the DataMate program. The program will detect auto-ID sensors. Non auto-ID sensors can be set up manually. (Refer to the *DataMate Guidebook* for help.)
   a. Select SETUP from the main screen.
   b. Press ▲ to select MODE and press ENTER.
   c. Select TIME GRAPH from the SELECT MODE menu.
   d. Select CHANGE TIME SETTINGS from the TIME GRAPH SETTINGS menu to set the data collection rate.
   e. Enter the time between samples in seconds (remember to finish your entry with ENTER).
   f. Enter the number of samples.
3. Set up the interface for manual triggering.
   a. Select ADVANCED from TIME GRAPH SETTINGS.
   b. Select CHANGE TRIGGERING from ADV. TIME GRAPH SETTINGS.
   c. Select MANUAL from SELECT TRIGGERING.
   d. Select OK three times to return to the main screen.
4. Select START to prepare LabPro for data-collection. The yellow light will come on, two beeps will be made, and a message will appear stating that remote data collection has been set up.
5. Press ENTER to return to the main screen and choose Quit.

6. Disconnect LabPro from the calculator. To start data collection, press the START/STOP button on LabPro. The yellow light will go off and the green light will blink during data collection.
7. When the green LED stops blinking and data collection is done, attach LabPro to the same calculator and start the DataMate program. The program will detect that data has been collected by LabPro and will display a message about retrieving the data. Press ENTER on the calculator. On the main screen, select TOOLS, and then select RETRIEVE DATA on the TOOLS menu. The data will be retrieved and one or more graphs made available.

Appendix A: Troubleshooting Tips

Problem	Cause/Solution
When LabPro is used with the computer, the Logger Pro Collect button does not appear.	The Collect button does not appear because the computer could not communicate with the interface. Check each of the following: • Make sure the cables are firmly attached. • Make sure LabPro is connected to the correct port on the computer. • Confirm that the port on the computer is working properly. Make sure the interface has power—either AC or battery.
When LabPro is used with a TI Graphing Calculator, a link error message will not go away.	This message appears when the calculator cannot communicate with the interface. Check each of the following: • Make sure the cables are firmly attached to the calculator and LabPro. • Make sure the interface has power—either AC or battery.
The sensor is not working.	This may be happening because the sensor is not plugged into the correct port. Since LabPro has 4 analog and 2 digital ports, make sure that the sensor is connected to the proper port.
The readings are noisy.	LabPro may be picking up interference from other electrical devices, such as a computer. Move the LabPro interface at least 30 cm from another computer.
When LabPro is plugged into AC power, the lights and beeps are not generated.	When LabPro powers up, lights and beeps signal a successful self-test. If batteries are already installed in LabPro, the self-test will not be performed.
When connected to USB, a light can be seen blinking inside the interface.	This is normal operational when LabPro is used through a USB port.

Appendix B: Beep Sequences

LabPro makes four kinds of sounds or "beeps":

- A "good" beep is a medium tone followed by a high tone.
- A "caution" beep is a medium tone followed by another medium tone.
- A "bad" beep is two high tones.
- A "tick" sound is made when a key is pressed.

The following bullets explain when beep sequences occur and what the beep sequences mean.

- When LabPro completes initialization, you will hear the startup sequence: bad beep, caution beep, good beep (6 total beeps, plus LEDs light up in this order: red LED, yellow LED, and green LED)
- When you press the QUICK SETUP button:
  - the caution beep sounds if a sensor is attached to LabPro.
  - the bad beep sounds if no sensors are attached to LabPro.
- When LabPro is connected to a calculator during sampling commands:
  - the caution beep sounds when initializing data collection.
  - the caution beep sounds when starting data collection (transition from pre-store to store).
  - the caution beep sounds when completing data collection.

Note 1: If the sampling timing causes the beeps to run together, the LabPro software may not sound all the beeps.
Note 2: You will not get all the beeps when Fast Sampling is enabled.
Note 3: You will not get all the beeps when using triggering.

- When you set LabPro for manual trigger and press the START button, a caution beep sounds.
- When you press the TRANSFER button:
  - the good beep sounds when the transfer succeeds.
  - the bad beep sounds if the transfer fails for any reason.
- When an overcurrent condition is detected, five bad beeps sound. (This causes an error, which causes even more beeps to sound.)
- When LabPro begins a full self-test, three good beeps sound.
- When self-test completes:
  - the good beep sounds if self-test passes.
  - the bad beep sounds if self-test fails.
- When LabPro's base code detects an error in the commands sent from the host, a bad beep sounds twice.
- When LabPro powers up:
  - two bad beeps sound if the base code is not loaded.
  - three bad beeps sound if the power-up self-test fails.
- During base code download, three bad beeps sound when any errors occur. (The unit resets and then the two bad beeps mentioned in the previous bullet sound.)

Appendix C: Support Materials for LabPro

Sensors

Over forty different sensors can be used with LabPro. They include:

Sensor/Probe	Order Code	Price
3-Axis Accelerometer	3D-BTA	$199
25-g Accelerometer	ACC-BTA	$91
Low-g Accelerometer	LGA-BTA	$90
Barometer	BAR-BTA	$58
CO_2 Gas Sensor	C02-BTA	$261
Colorimeter	COL-BTA	$99
Conductivity Probe	CON-BTA	$81
Current & Voltage Probe System	CV-BTA	$86
Digital Control Unit	DCU-BTD	$61
Dissolved Oxygen Probe	DO-BTA	$191
Dual-Range Force Sensor	DFS-BTA	$99
EKG Sensor	EKG-BTA	$142
Exercise Heart Rate Monitor	EHR-BTA	$91
Extra Long Temperature Probe	TPL-BTA	$70
Gas Pressure Sensor	GPS-BTA	$71
Heart Rate Monitor	HRM-BTA	$49
Flow Rate Sensor	FLO-BTA	$129
Instrumentation Amplifier	INA-BTA	$51
Ammonium Ion-Selective Electrode	NH4-BTA	$165
Calcium Ion-Selective Electrode	CA-BTA	$165
Chloride Ion-Selective Electrode	CL-BTA	$165
Nitrate Ion-Selective Electrode	NO3-BTA	$165
Light Sensor	LS-BTA	$45
Magnetic Field Sensor	MG-BTA	$46
Microphone	MCA-BTA	$35
Motion Detector	MD-BTD	$64
O_2 Gas Sensor	O2-BTA	$186
pH Sensor	PH-BTA	$74
Radiation Monitor	RM-BTD	$205
Relative Humidity Sensor	RH-BTA	$67
Respiration Monitor Belt	RMB	$58
(requires GPS-BTA or BGP-DIN)		
Rotary Motion Sensor	RMS-BTD	$187
Stainless Steel Temperature Probe	TMP-BTA	$29
Student Force Sensor	SFS-BTD	$99
Student Radiation Monitor	SRM-BTD	$145
Turbidity Sensor	TRB-BTA	$99
Thermocouple	TCA-BTA	$37
Vernier Photogate	VPG-BTD	$41
Voltage Probe	VP-BTA	$9

Adapters for Older Sensors

Vernier sensors purchased prior to the introduction of LabPro can probably be adapted to work with LabPro. Most of our analog sensors were previously manufactured with a round, 5-pin "DIN" plug. If you have one of these older DIN sensors, you will need a DIN-to-BTA adapter (order code DIN-BTA, $5). This chart shows some of the adapters that can be used with other sensors. You may have sensors that do not appear in this table. Contact us to discuss your situation.

Sensors Purchased Prior to 2000	Adapter	Order Code, Price
Vernier Analog 5-pin DIN sensors	DIN to BTA adapter	DIN-BTA, $5
Vernier Assembled Photogate, Smart Pulley™, Radiation Monitors	LabPro Digital Adapter	DG-BTD, $5
Older ULI Motion Detector	CBL-RJ11 Adapter	CBL-RJ11, $5
New ULI Motion Detector	LabPro/CBL Motion Detector cable	CBL-MDC, $5
Rotary Motion Sensor	Rotary Motion Adapter	ROT-BTD, $5

Additional Manuals

There are a number of additional manuals that can help you use LabPro with a computer or calculator.

LabPro Technical Reference – The reference provides detailed information on the LabPro hardware and the software command structure. This manual is available free from our web site, www.vernier.com.

Logger Pro Tutorials – This manual provides an excellent introduction to the Logger *Pro* software. The tutorials show you how to collect data with a Temperature Probe and a Motion Detector. It also introduces you to the analysis features of the program.

Logger Pro User's Manual – This manual is a complete reference to the software. This manual and the Logger *Pro* Tutorials are a part of the Logger *Pro* package. The User's Manual can also be found on the Logger *Pro* software CD.

DataMate Guidebook – This guidebook provides a complete look at the DataMate calculator program. This manual can also be downloaded from our web site, www.vernier.com.

Lab Manuals - Lab manuals in physical science, biology, chemistry, physics and water quality enable you and your students to quickly begin using LabPro in the classroom and in the field. Each manual contains

- Ready-to-use student experiments.
- Teacher section for each experiment with complete directions, helpful hints, and sample graphs and data.
- Word processing files of the student sections on CD, so labs may be edited to your specifications.

Physical Science with Computers .....PSC-LP $35
Physical Science with Calculators .....PSCALC.....$35

Some of the experiments are

- Energy Content of Foods and Fuels
- Reflectivity of Light
- Acid Rain
- First-Class Levers and Pulleys
- Lemon "Juice"
- Graphing Your Motion

Biology with Computers.....BWC-LP.....$35
Biology with Calculators.....BWCALC $35

Some of the experiments are

- Diffusion through Membranes
- Transpiration
- Biological Membranes
- Cellular Respiration
- Photosynthesis
- Watershed Testing

Chemistry with Computers .....CWC-LP $35
Chemistry with Calculators .....CWCALC....$35

Some of the experiments are

- Vapor Pressure of Liquids
- Hess's Law
- Determining the Concentration of a Solution
- Conductivity of Saltwater
- Acid-Base Titration
- Pressure-Temperature Relationship in Gases

Physics with Computers.....PWC-LP $35
Physics with Calculators.....PWCALC $35

Some of the experiments are

- Newton's Second Law
- Projectile Motion
- Ohm's Law
- Bungee Jump Accelerations
- Sound Waves and Beats
- Accelerations in the Real World

Water Quality with Computers .....WQC-LP $35
Water Quality with Calculators .....WQCALC ...$35

Some of the experiments are

- Total Solids
- BOD
- Fecal Coliform
- Ammonium Nitrogen
- Dissolved Oxygen
- Phosphates, Ortho- and Total
- Nitrate
- Stream Flow